CLAIMS

What is claimed is:

1. A navigation system, comprising:

(a) a GPS receiver adapted to receive electromagnetic signals from a plurality of satellites, said GPS having a first output for providing a signal indicative of the position of said GPS receiver;

(b) a magnetometer positionable for measuring one or more components of the earth's magnetic field, said magnetometer having a second output for providing a signal indicative thereof;

(c) an accelerometer for measuring one or more axes of acceleration, said accelerometer having a third output for providing a signal indicative thereof; a

(d) a 3-axes rate gyroscopes for measuring the rate of rotation of the navigational system, said rate gyroscope having a fourth output for providing a signal indicative thereof; and

(e) a computing device having:

(i) a plurality of inputs, at least one input of said plurality of inputs in communication with each of said first, second, third, and fourth outputs; and

(ii) a database of the magnetic fields of the earth.

2. The navigation system of claim 1 further comprising one or more barometric sensors, for measuring atmospheric pressure and providing signals indicative thereof.

3. The navigation system of claim 1 wherein said 3-axes rate gyroscope is a MEMS based rate gyroscope.

4. The navigation system of claim 1 further comprising a display means for visually displaying information from said computing device.

5. The navigation system of claim 1 further comprising an aural transducer for communicating audible information from said computing device.

6. The navigation system of claim 1 further comprising a battery wherein the operating power for the navigation system is supplied by said battery.

7. The navigation system of claim 1 further comprising an RF data link configured for digital communication.

8. The navigation system of claim 1 further comprising nonvolatile memory for storing flight navigational information.

9. The navigation system of claim 1 further comprising an interface for communicating with avionic systems of an aircraft.

10. The navigation system of claim 1 further comprising a sensor for determining the braking status of a vehicle when the system is installed in said vehicle.

11. The navigation system of claim 1 further comprising a sensor for determining the position of a throttle in a vehicle when the system is installed in said vehicle.

12. The navigation system of claim 1 wherein the navigation system is configured for portable operation.

13. The navigation system of claim 4 wherein said display shows at least one of the navigational components selected from the group consisting of:

(a) position;

(b) heading;

(c) velocity;

(d) acceleration;

(e) pitch;

(f) roll; and

(g) track angle.

14. The navigation system of claim 1 wherein said computing device includes a Kalman filter and wherein said first, second, third, and fourth outputs provide inputs to said Kalman filter.

15. A method for managing the electrical power in the navigation system of claim 1 when the navigation system is in a power-conserving mode including the steps of:

(a) applying power to said accelerometer;

(b) reading the acceleration of the system from said accelerometer;

(c) determining if the system is in motion;

(d) if the system is in motion,

(i) terminating the power conserving mode; and

(i)(i) applying power to the remaining circuitry of the navigation system; and

(e) if the system is not in motion,

(i) removing power from said accelerometers;

(ii) delaying a period of time; and

(iii) repeating steps (a)-(e).

16. The navigation system of claim 1 wherein said computing device includes database information selected from the group consisting of:

(a) 2-D map information;

(b) topographical information; and

(c) oceanographic information,

17. The navigation system of claim 1 further comprising a memory card.

18. The navigation system of claim 17 further including at least one protectant for said memory card selected from the group consisting of:

(a) inertia absorbing material;

(b) heat insulating material; and

(c) corrosion resistant conformal coating.

19. A navigation system, comprising:

a Global Positioning Sensor receiver adapted to receive electromagnetic signals from a plurality of satellites to determine a position, said Global Positioning Sensor receiver having a first output for providing a signal indicative said position;

an accelerometer for measuring one or more independent components of acceleration, said accelerometer having a second output for providing a signal indicative of said one or more independent components of acceleration;

a rate gyroscope for measuring three independent components of rate of rotation, said rate gyroscope having a third output for providing a signal indicative of said three independent components of rate of rotation;

a computing device having a plurality of inputs for in communication with said first, second, and third outputs; and

a housing wherein is housed said Global Positioning Sensor receiver, said accelerometer, and said rate gyroscope, wherein said housing is configured such that the navigation system is portable.

20. The navigation system of claim 19 wherein said rate gyroscopes are MEMS based.

21. The navigation system of claim 19 further comprising a barometric sensor for measuring the altitude of the navigation system.

22. The navigation system of claim 19 further comprising a display for visually displaying navigation information to an operator.

23. The navigation system of claim 19 further comprising an audio transducer for providing information aurally to an operator.

24. The navigation system of claim 19 further comprising a battery housed in said housing for providing electrical power for the operation of the navigation system.

25. The navigation system of claim 19 further comprising a data link for communicating with other navigation systems.

26. The navigation system of claim 19 further comprising a memory card readable and writable by said computing device.

27. The navigation system of claim 19 portable for use on a craft, further including a braking system sensor for measuring a braking force of the craft.

28. The navigation system of claim 19 portable for use on a craft, further including a throttle position sensor for measuring a throttle position of the craft.

29. The navigation system of claim 19 portable for use on a craft, further including a tamper determining means to detect tampering with the craft.

30. The navigation system of claim 29 further comprising a keypad for inputting navigational information to said computing device and for inputting a code to distinguish legitimate use of the craft from tampering.

31. The navigation system of claim 22 wherein said display can be configured to display at least one navigational parameter selected from the group consisting of:

(a) the track of a vehicle;

(b) the heading of the vehicle;

(c) the velocity of the vehicle;

(d) the acceleration of the vehicle;

(e) the pitch and roll of the vehicle; and

(f) the braking status of the vehicle.

32. The navigation system of claim 19 wherein said computing device processes the signals from said first, second, and third outputs through a Kalman filter.

33. A method for managing the electrical power in the navigational system of claim 19 including the steps of:

(a) applying power to said accelerometer;

(b) reading the acceleration of the system from said accelerometer;

(c) determining if the system is in motion;

(d) if the system is in motion,

(i) terminating the power conserving mode; and

(i)(i) applying power to the remaining circuitry of the navigation system; and

(e) if the system is not in motion,

(i) removing power from said accelerometers;

(ii) delaying a period of time; and

(iii) repeating steps (a)-(e).

34. The navigation system of claim 25 wherein said data link further comprises a radio frequency transceiver configured for the wireless transmission and reception of digital information.

35. The navigation system of claim 34 wherein said radio frequency transceiver is further configured to communicate with a satellite.

36. The navigation system of claim 35 wherein said satellite is part of a network of communication satellites.

37. The navigation system of claim 19 wherein said computing device includes database information selected from the group consisting of:

(a) 2-D map information;

(b) topographical information; and

(c) oceanographic information,

38. The navigation system of claim 19 further comprising a memory card.

39. The navigation system of claim 38 further including at least one protectant for said memory card selected from the group consisting of:

(a) inertia absorbing material;

(b) heat insulating material; and

(c) corrosion resistant conformal coating.

40. A ground collision avoidance system for use at an airport to prevent incursions between aircraft, vehicles, people, and objects comprising:

a navigation system including a MEMS based inertial measurement unit, said navigation system portable and used to provide a position of an aircraft, a vehicle, a person, or in immediate proximity of an object;

a transmitter for transmitting said position of said aircraft, said vehicle, said person, or said object;

a receiver for receiving a position of other nearby ground collision avoidance systems; and

a display for displaying said position of nearby aircraft relative to the position of said aircraft, said vehicle, said person, or said object.

41. The ground collision avoidance system of claim 40 wherein each aircraft, vehicle, person, and object which transmits a position has a unique identifier and said unique identifier is included in each transmission.

42. The ground collision avoidance system of claim 41 further comprising a brake sensor and wherein said transmitter transmits said brake sensor data.

43. The ground collision avoidance system of claim 41 further comprising a thrust sensor and wherein said transmitter transmits engine thrust data.

44. The ground collision avoidance system of claim 40 further comprising an interface, said interface for communication with a flight data recorder.

45. The ground collision avoidance system of claim 40 wherein said navigation system further provides a heading of said aircraft, said vehicle, or said person and wherein said transceiver transmits said heading.

46. The ground collision avoidance system of claim 40 wherein said system is portable to be moved from said aircraft, said vehicle, said person, or said object to another aircraft, vehicle, person, or object.

47. An air traffic control system comprising:

an aircraft in the vicinity of the air traffic control system;

a navigation system on board said aircraft for providing a position of said aircraft, said navigation system including a MEMS based inertial measurement unit;

a transmitter on board said aircraft configured to transmit said position;

an air traffic control facility configured to receive and display said position of said aircraft to an air traffic controller.

48. An integrated flight data recorder and navigation system comprising:

a navigation system for providing aircraft navigational parameters;

a nonvolatile memory device for recording and archiving said navigational parameters,

wherein said navigation system and said nonvolatile memory are integrated into a single housing.

49. The integrated flight data recorder and navigation system of claim 48 further comprising a plurality of inputs for receiving information from other aircraft systems, wherein said information is stored in said nonvolatile memory.

50. The integrated flight data recorder and navigation system of claim 49 further comprising:

a transmitter in communication with said navigation system such that a portion of said navigational parameters and said information are transmitted to a ground based station.

51. The integrated flight data recorder and navigational system of claim 50 wherein said central ground station includes a processor for analyzing said navigational parameters and said information and said navigational parameters and said information are adequate to allow the prediction of a crash site in the event of a crash.

52. The integrated flight data recorder and navigation system of claim 50 wherein said navigational parameters and said information comprise the information recorded in said nonvolatile memory.

53. The integrated flight data recorder and navigation system of claim 48 wherein the integrated flight data recorder and navigation system is portable.

54. A ground incursion system, comprising:

a plurality of craft, each of said craft equipped with:

a navigation system which provides a position of said craft; and

a transmitter for configured to transmit said position; and

an accelerometer in at least one of the craft for sensing movement of said craft, said accelerometer having an output providing a signal indicative of movement of said craft and including said signal in said transmission; and

a central station comprising:

a receiver for receiving said position and said movement from said craft; and

a processor for evaluating the movements of each craft of said plurality of craft and predicting collisions between two or more craft of said plurality of craft.

55. A low-cost navigation system comprising:

a magnetometer for measuring one or more independent components of the earth's magnetic field, said magnetometer having an output providing a signal indicative of the earth's magnetic field; and

a means for inputting a position on the earth's surface; and

a computing device comprising:

an input for receiving said output; and

a database of the earth's magnetic field,

wherein the attitude of navigation system may be determined by comparing said position, and the direction of the earth's magnetic field, with information contained in said database.

56. The low-cost navigation system of claim 55 wherein said means for inputting a position on the earth's surface comprises a GPS receiver for determining the position of the navigation system and wherein said database is structured such that the stored

direction of the earth's magnetic field is arranged relative to discrete positions on the earth's surface.

57. A method for determining the attitude of a craft comprising:

(a) affixing a magnetometer to the craft such that the direction of the earth's magnetic field may be measured relative to an axis of said craft;

(b) providing a database of the earth's magnetic field relative to positions on the earth's surface;

(c) providing a positioning system for indicating the position of the craft;

(d) obtaining a position of the craft from said positioning system;

(e) obtaining the direction of the earth's magnetic field relative to the craft from said magnetometer;

(f) finding the direction of the earth's magnetic field from said database at said position obtained in step (d); and

(g) finding the difference between said direction of earth's magnetic field relative to the craft obtained in step (e) and the direction of the earth's magnetic field found in said database in step (f).

58. A method for managing the electrical power of a navigation system when the navigation system is in a power-conserving mode including the steps of:

(a) providing a positioning system for indicating the position of said system;

(b) providing a motion sensor system for indicating movement;

(c) applying power to said motion sensor;

(b) reading the movement of the system from said motion sensor;

(c) determining if said system is in motion;

(d) if the system is in motion,

(i) terminating the power conserving mode; and

(i)(i) applying power to the remaining circuitry of the navigation system; and

(e) if the system is not in motion,

(i) removing power from said motion sensor;

(ii) delaying a period of time; and

(iii) repeating steps (a)-(e).

59. An air traffic warning system comprising:

an aircraft in the vicinity of an air traffic control system;

a receiver on board said aircraft configured for the wireless reception of digital information;

a transmitter linked to an air traffic control facility configured for the wireless transmission of digital information.

wherein a predetermined message is provided on said aircraft upon receipt of a particular code sent from said air traffic control facility via wireless transmission means.